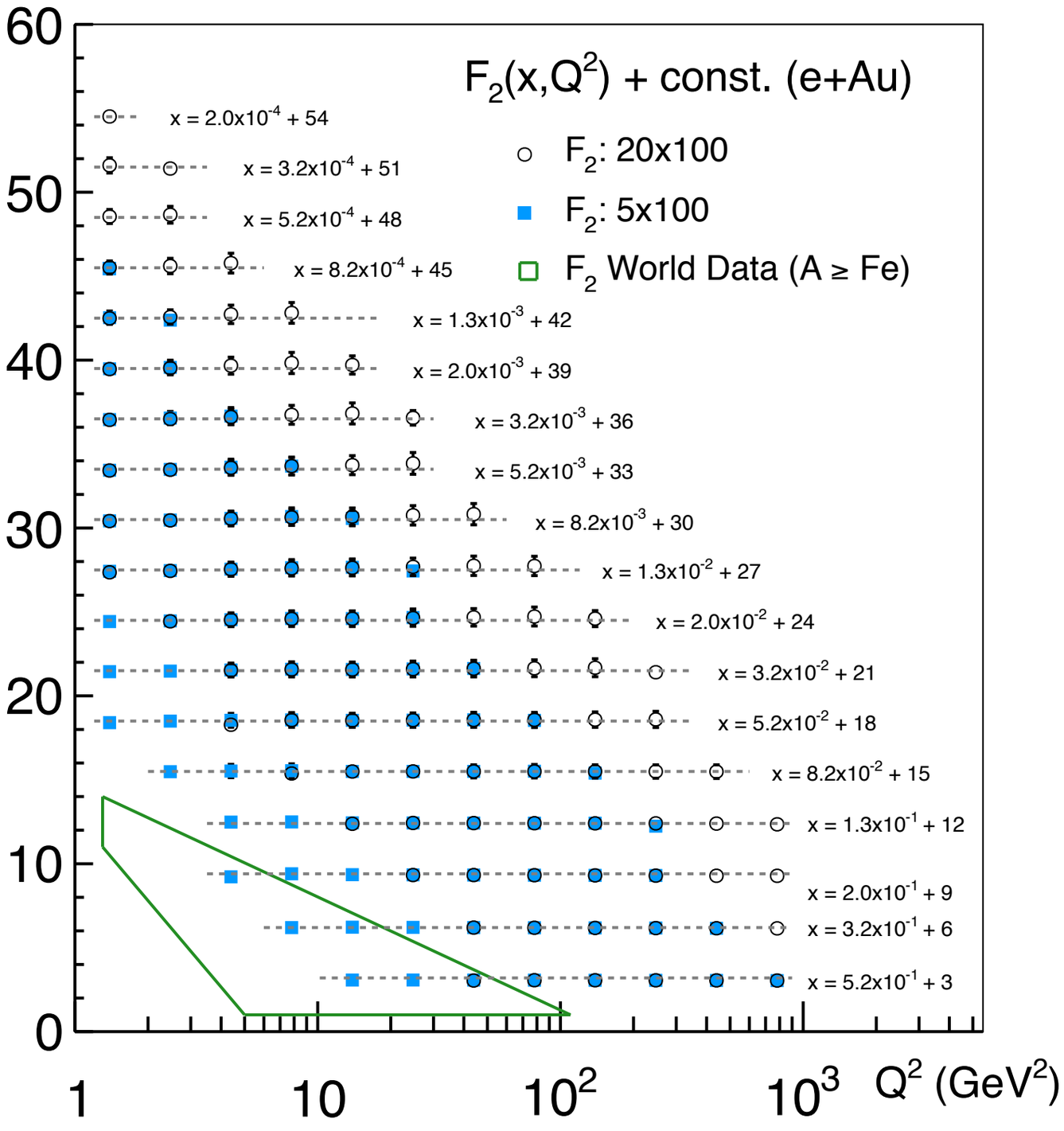
Update on Study of Structure Functions at eRHIC

Matthew A. C. Lamont
BNL

BROOKHAVEN NATIONAL LABORATORY

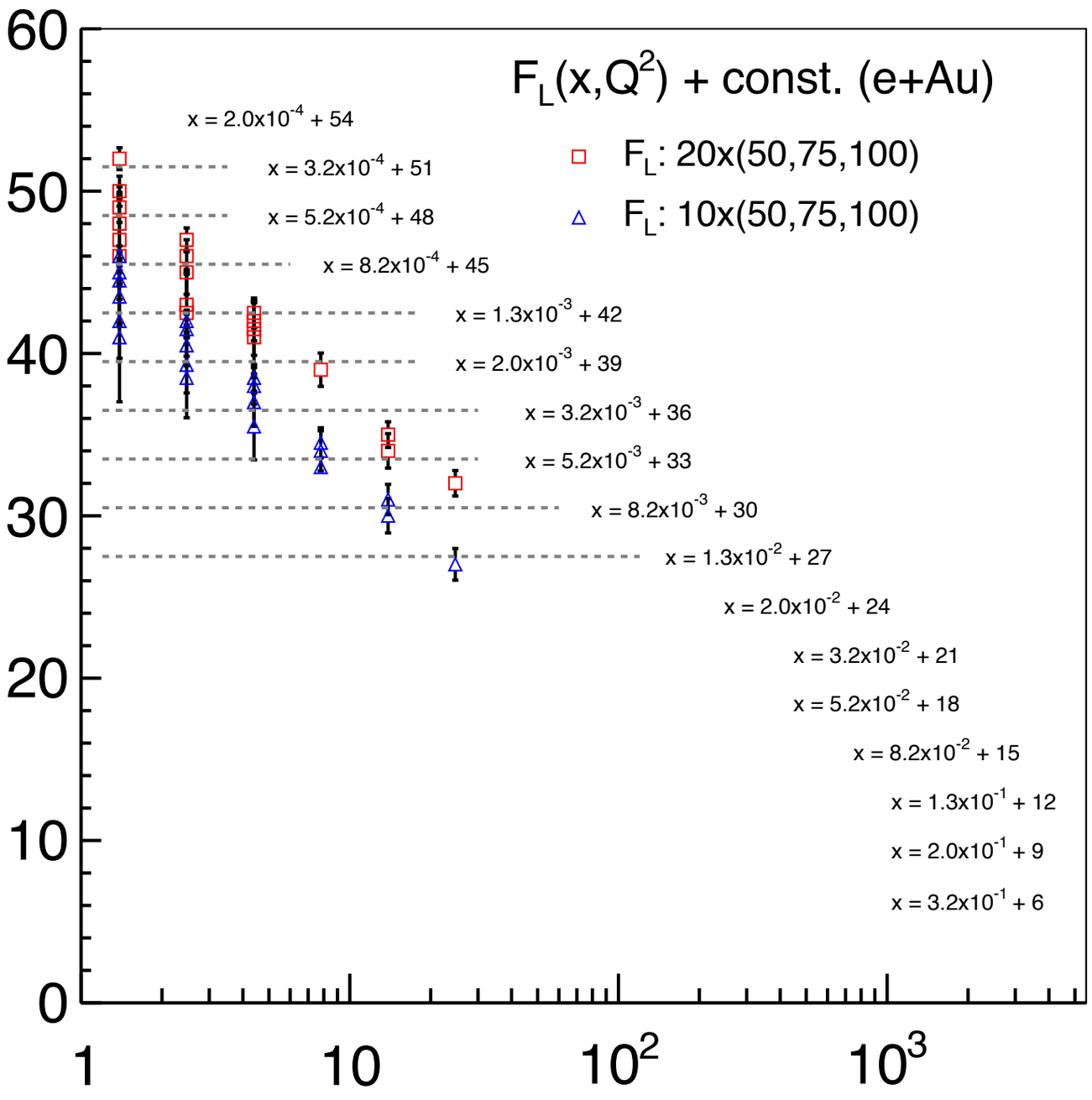
U.S. DEPARTMENT OF ENERGY

F_2 at eRHIC



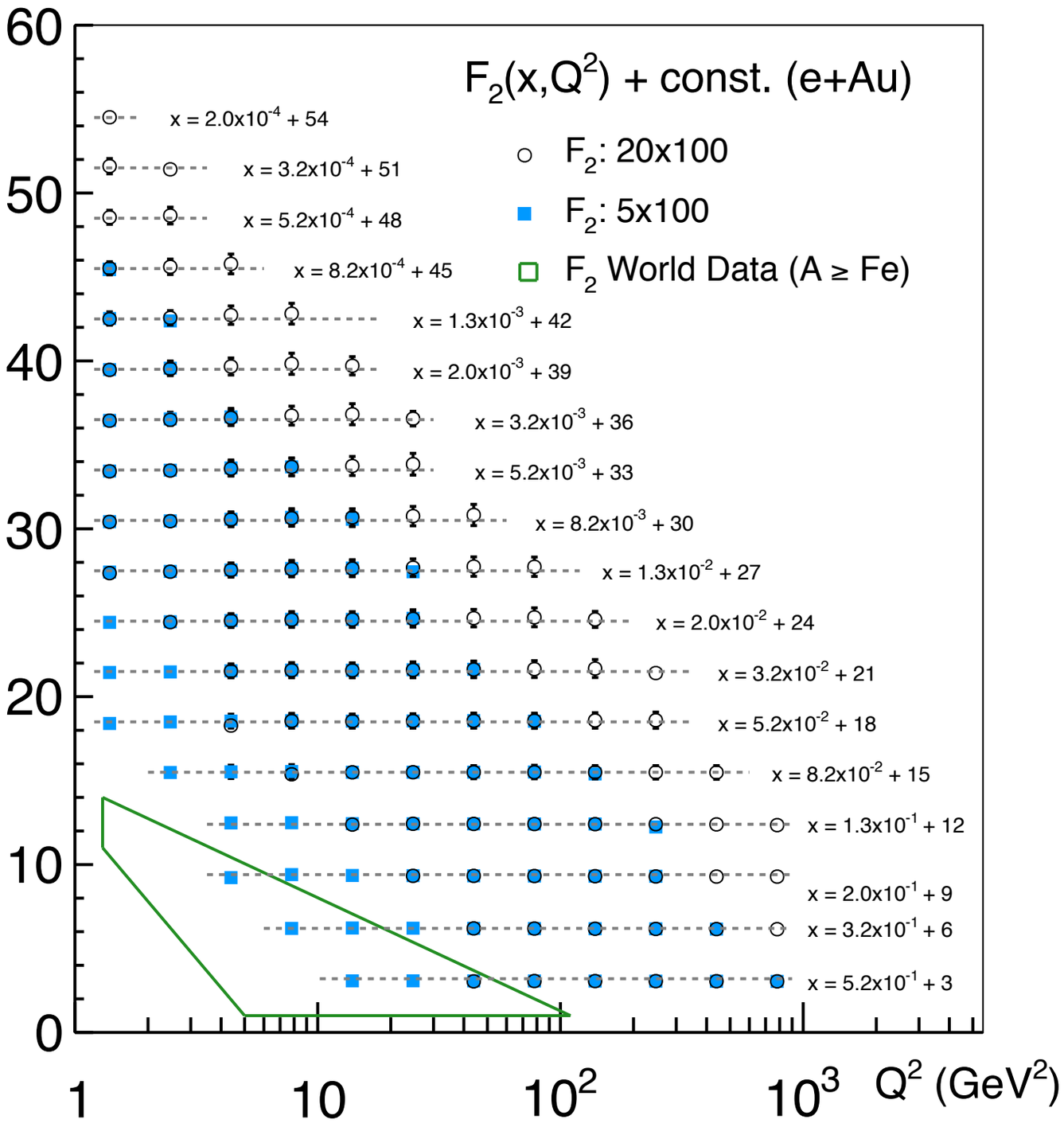
- Plot shown by Thomas at QM
- Nicely shows the (x,Q^2) coverage of eRHIC together with our anticipated uncertainties (dominated by 3% systematics)
- Scaling chosen to separate x-bins otherwise they would be on top of each other

F_L at eRHIC



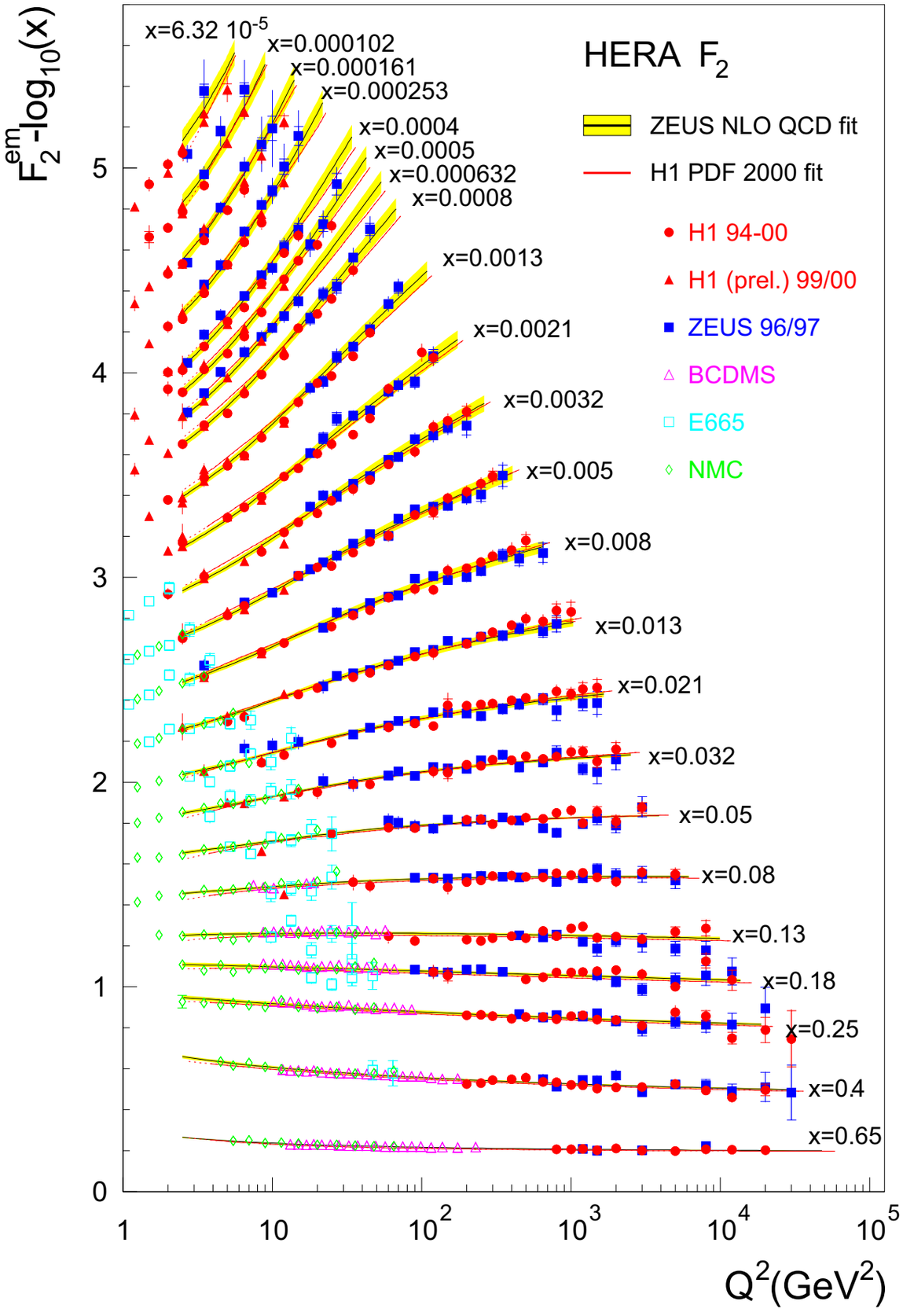
- $F_L(x,Q^2)$ plot on the same scale.
- Smaller coverage in (x,Q^2) compared to F_2. This is expected because each point needs phase-spce coverage from 3 different energies.
- Error bars significantly larger than F_2.
- Scaling chosen to separate x-bins otherwise they would be on top of each other

What's the issue?



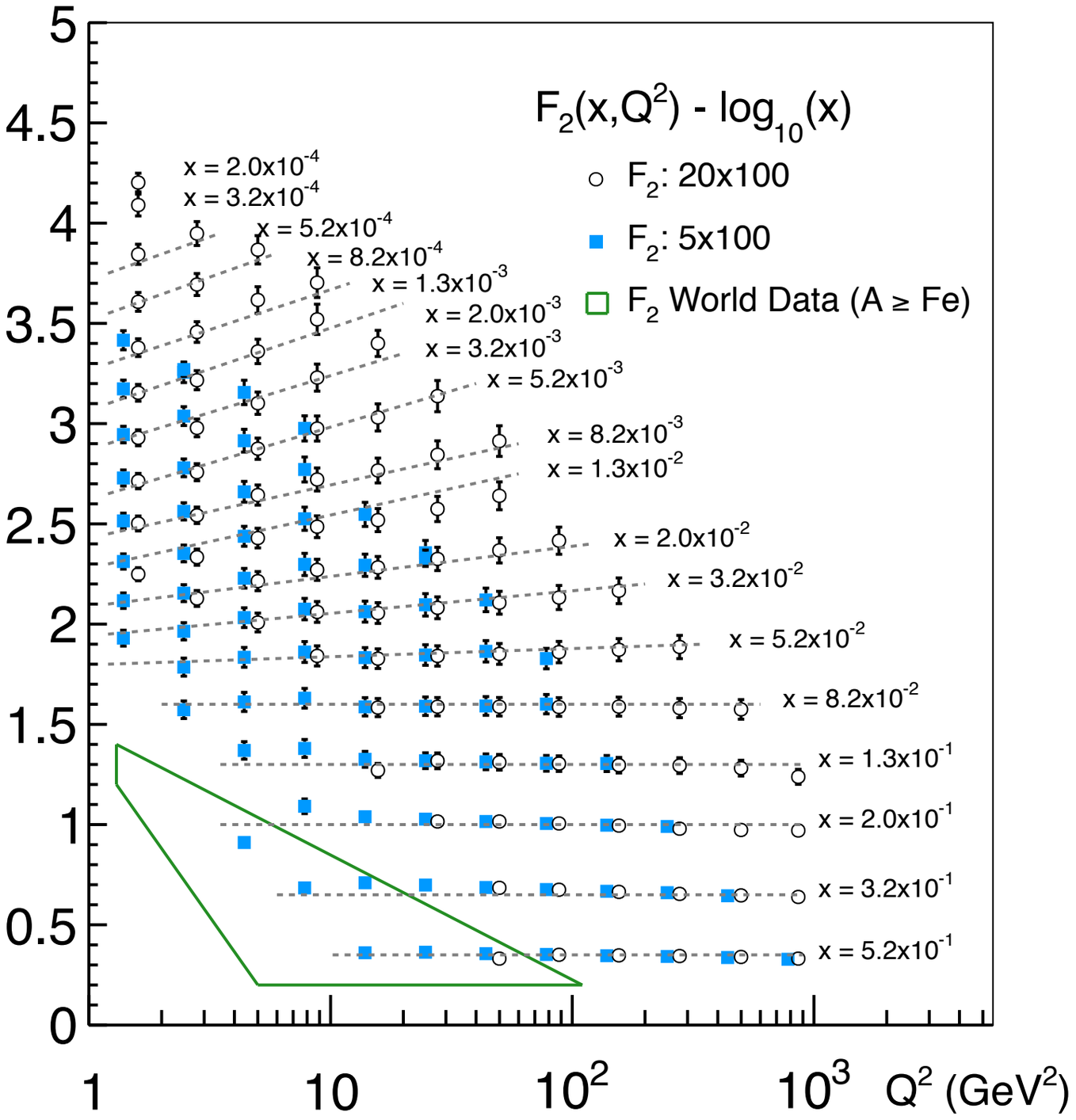
- Although this plot is pretty nice, as indicated by Nestor, it doesn't show any scaling violation.
- The reason for this is that the offsets applied to the data are much larger in scale than any scaling violation.

Try the HERA scaling



- They plotted F_2 - $\log_{10}(x)$.
- Note that the vertical scale goes up to 6, rather than 60…
- Here, the scaling violation at low-x is very nicely represented on the plot

F_2 at eRHIC

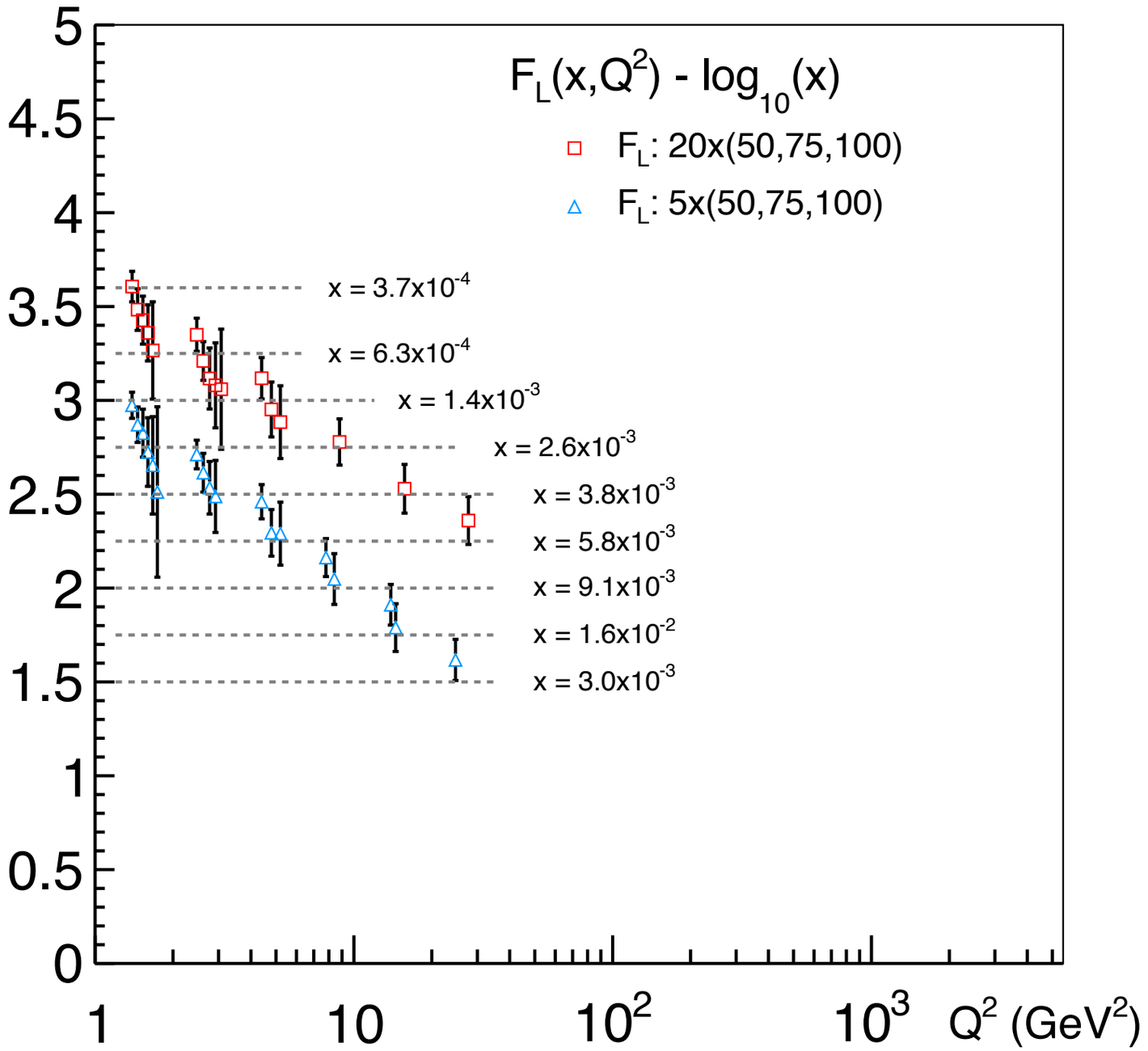


- New scaling - $F_2(x,Q^2)$ - $\log_{10}(x)$ shows the scaling violation well. It also keeps the aspects of the previous plot which shows our uncertainties well.

  ➡ Still dominated by the 3% systematic error.

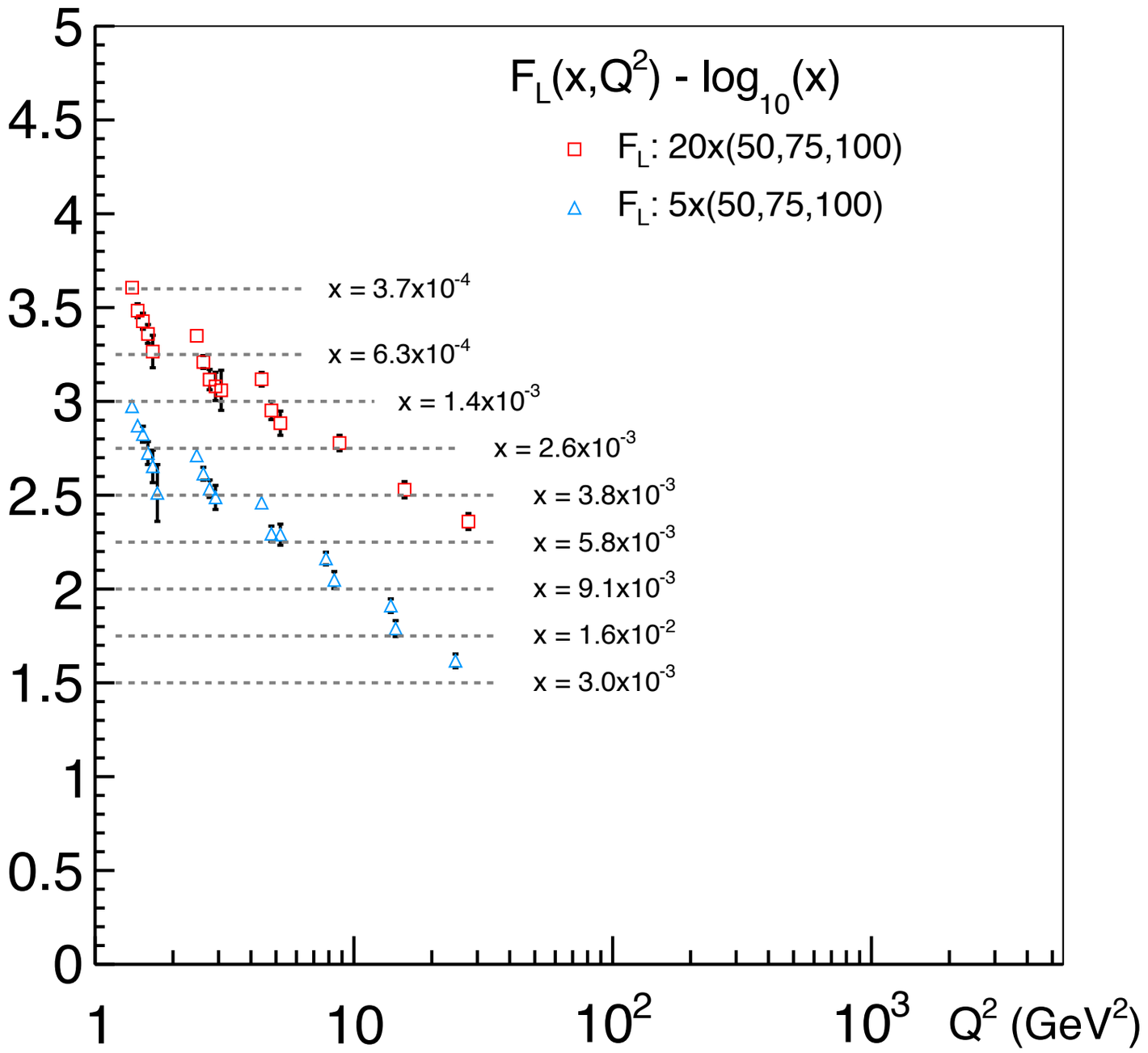
- The dashed lines are just there to "guide the eye" and have no physics input

F_L at eRHIC



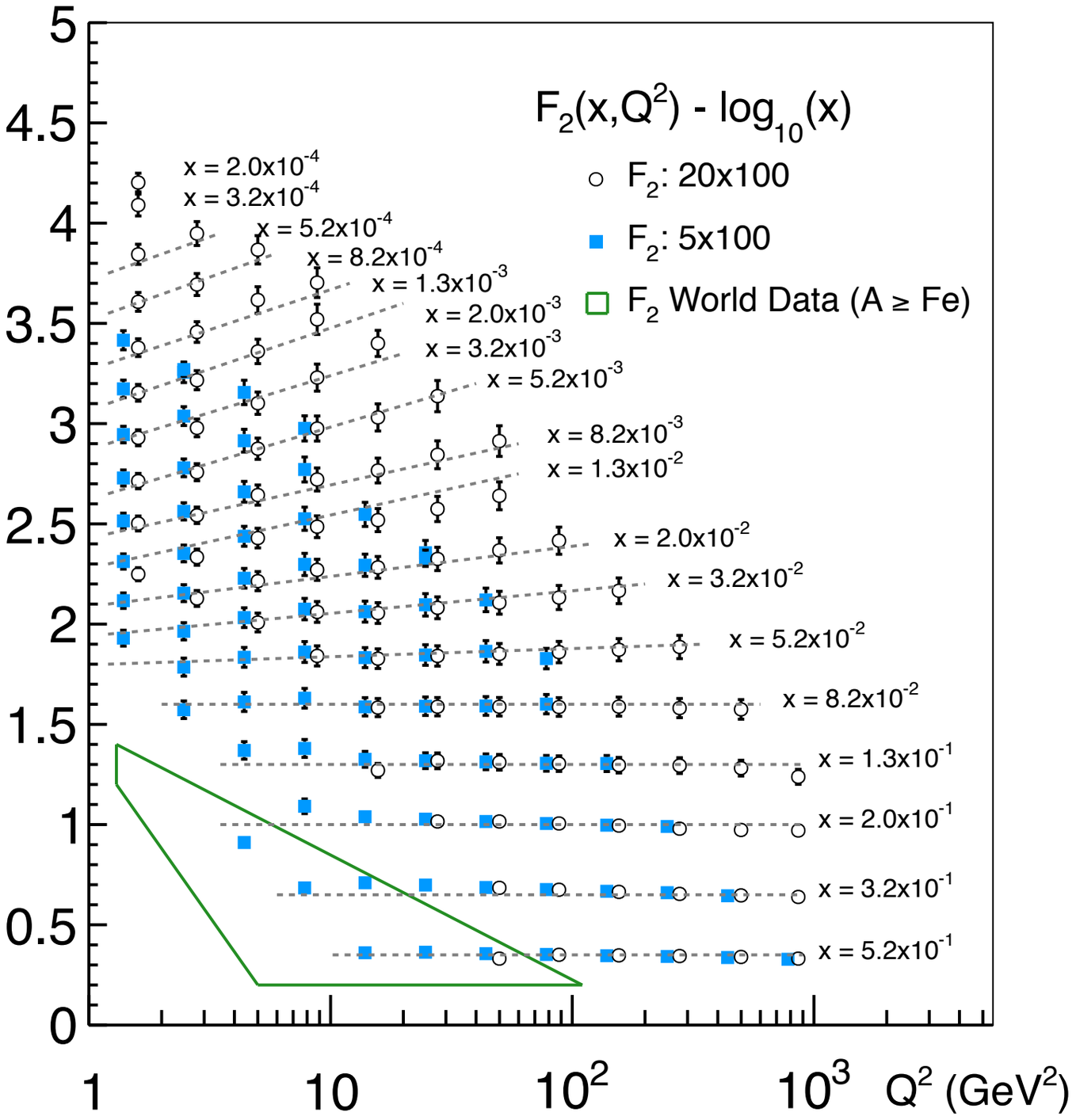
- New $F_L(x,Q^2)$ plot on the same scale.
- The points are separated in Q2 so that the uncertainties on each point can be seen better.
- Error bars significantly larger than F_2.
- Scaling shows approximately where the x of the points lie - unsure whether this would also have a slope

F_L at eRHIC



- New $F_L(x,Q^2)$ plot on the same scale.
- The points are separated in Q2 so that the uncertainties on each point can be seen better.
- Error bars significantly larger than F_2.
- Scaling shows approximately where the x of the points lie - unsure whether this would also have a slope

σ_{red} at eRHIC - e+Au@20x100 GeV

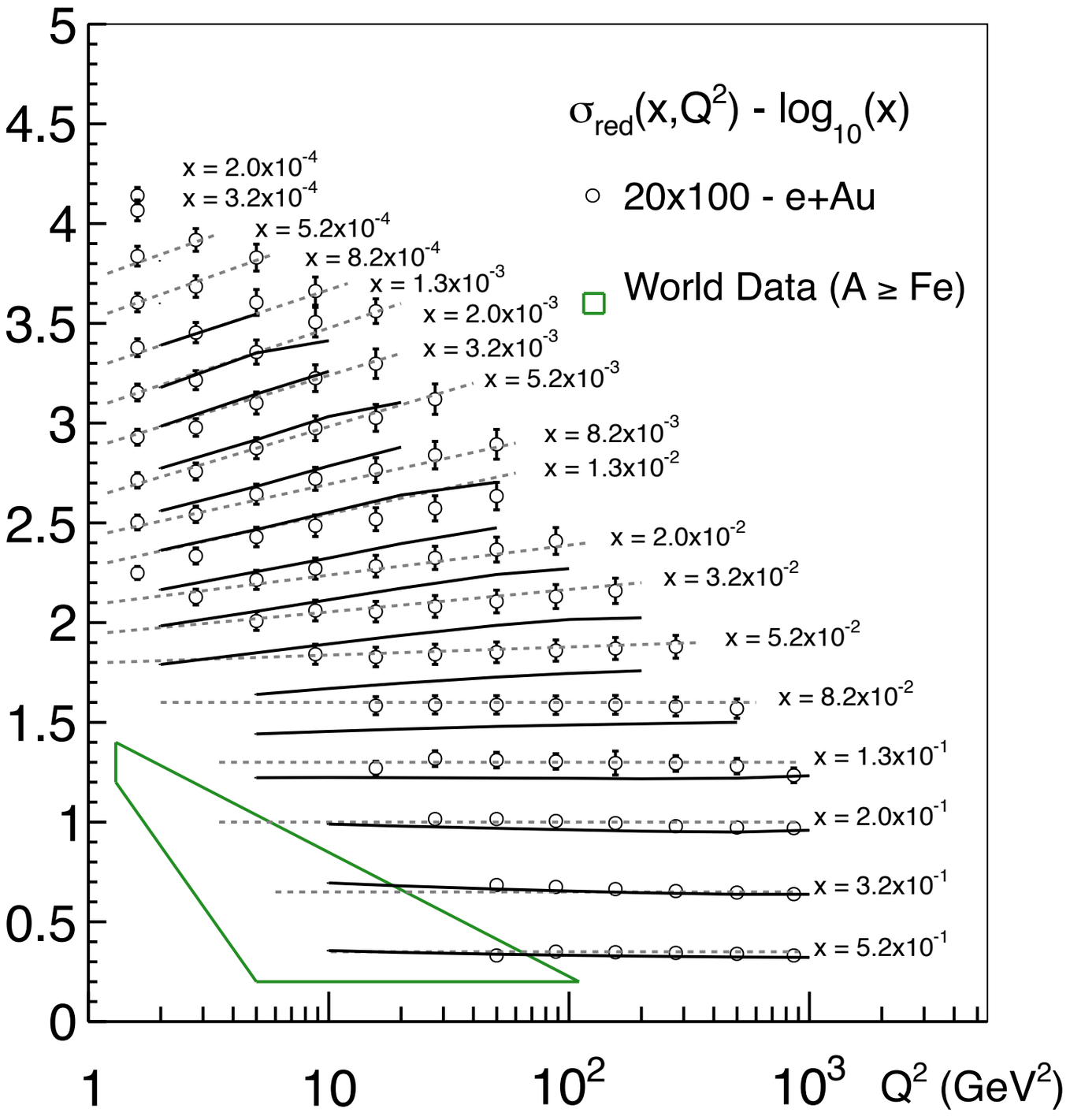


- New scaling - $F_2(x,Q^2)$ - $\log_{10}(x)$ shows the scaling violation well. It also keeps the aspects of the previous plot which shows our uncertainties well.
  - ➡ Still dominated by the 3% systematic error.
- The dashed lines are just there to "guide the eye" and have no physics input

What's the next stage?

- The HERA plot nicely showed an NLO QCD fit to the data.
- As we used EPS09 and PYTHIA to generate the data, we should be able to put the EPS09 curve through our data.
- I contacted Hannu and got the reduced cross-section data for e+Au and e+p from him. Unfortunately, only the mid-point value. I need to get the error bands as well although July in Finland is like August in France..

σ_{red} at eRHIC - e+Au@20x100 GeV

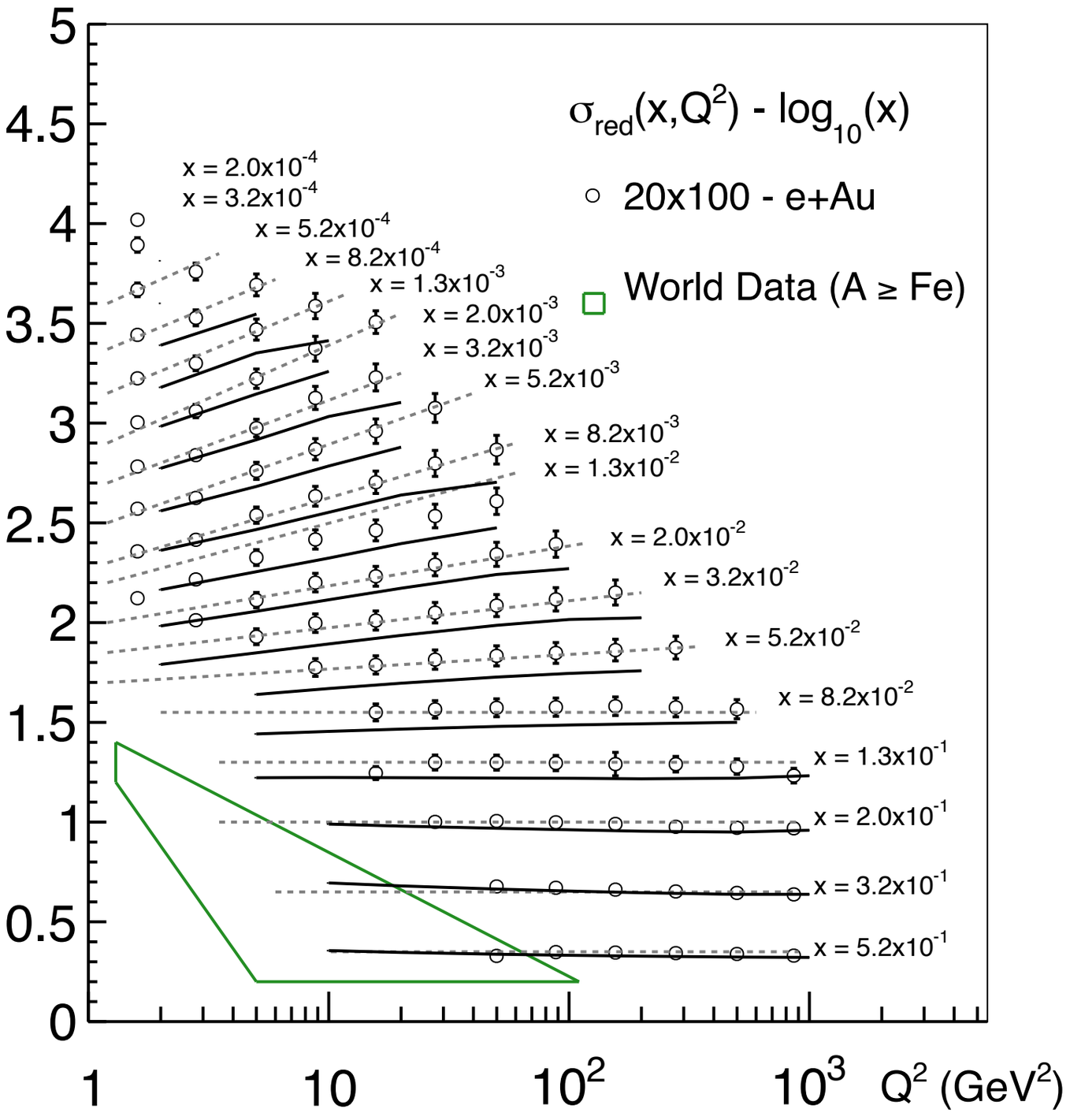


- New scaling - $F_2(x,Q^2)$ - $\log_{10}(x)$
- Dashed lines are there to guide the eye and go through the points
- The solid lines are input from Hannu

➡ No uncertainty information from him yet

- Points do a good job at high-x,Q^2 but a poor job at low-x,Q^2
- One possibility is that the data points contain diffractive events but he fits to data from high-x,Q^2 with little-to-no diffractive contribution

σ_{red} at eRHIC - e+Au@20x100 GeV

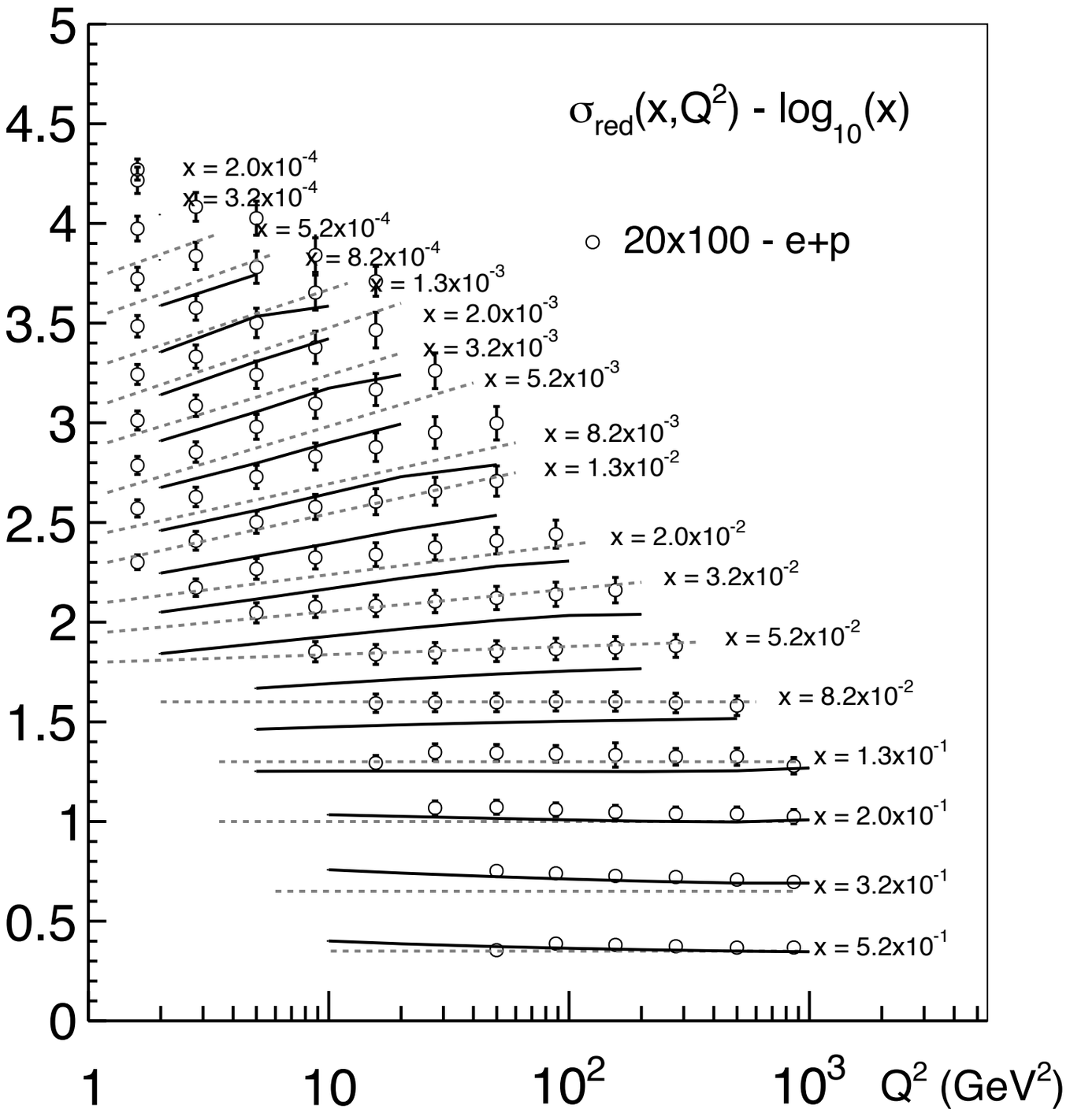


- New scaling - $F_2(x,Q^2)$ - $\log_{10}(x)$
- Dashed lines are there to guide the eye and go through the points
- The solid lines are input from Hannu

➡ No uncertainty information from him yet

- Points do a good job at high-x,Q^2 but a poor job at low-x,Q^2
- One possibility is that the data points contain diffractive events but he fits to data from high-x,Q^2 with little-to-no diffractive contribution

σ_{red} at eRHIC - e+p@20x100 GeV

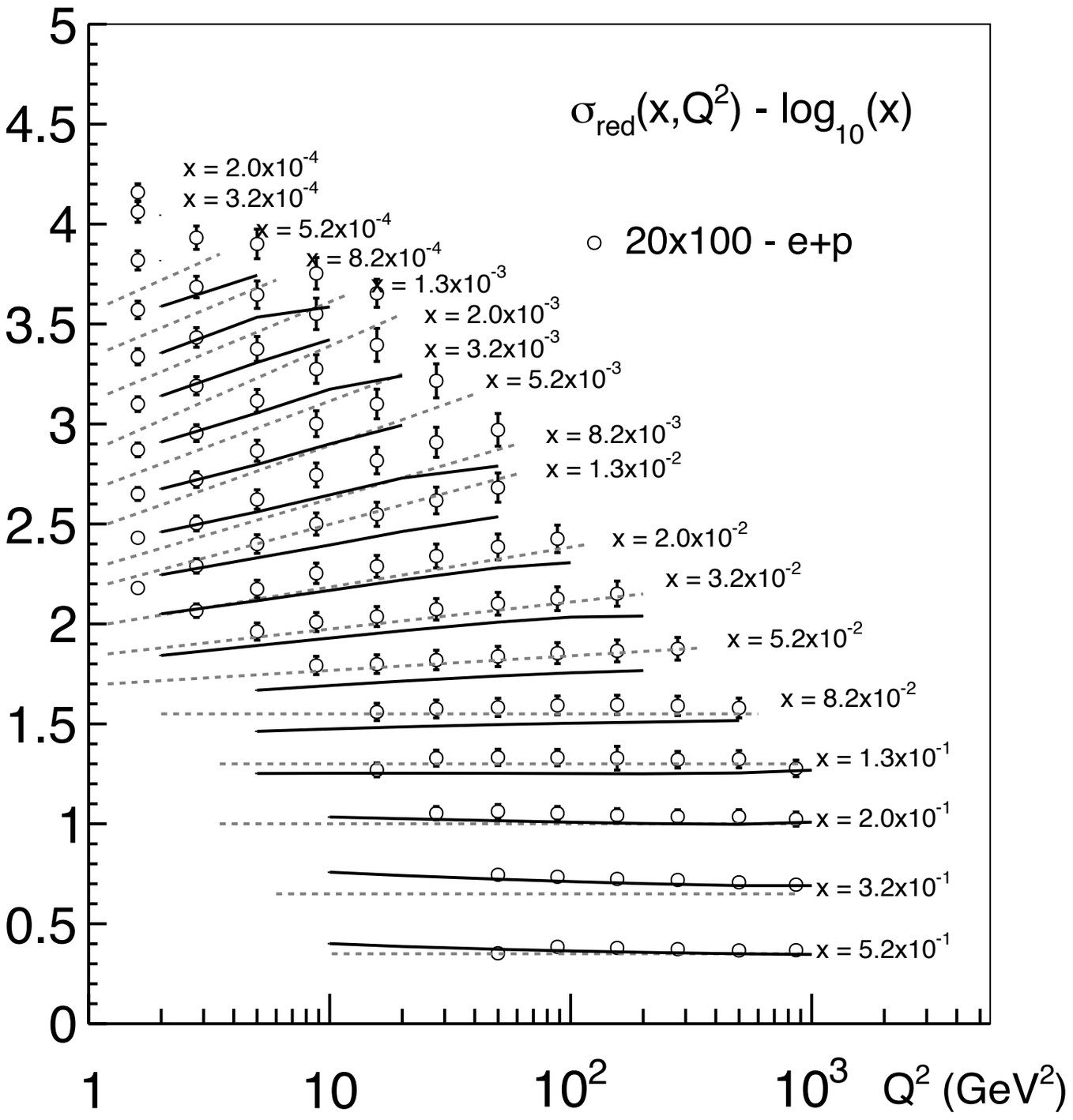


- New scaling - $F_2(x,Q^2)$ - $\log_{10}(x)$
- Dashed lines are there to guide the eye and go through the points
- The solid lines are input from Hannu

  ➡ No uncertainty information from him yet

- Points do a good job at high-x,Q^2 but a poor job at low-x,Q^2
- One possibility is that the data points contain diffractive events but he fits to data from high-x,Q^2 with little-to-no diffractive contribution

σ_{red} at eRHIC - e+p@20x100 GeV



- New scaling - $F_2(x,Q^2)$ - $\log_{10}(x)$
- Dashed lines are there to guide the eye and go through the points
- The solid lines are input from Hannu
  - ➡ No uncertainty information from him yet
- Points do a good job at high-x,Q^2 but a poor job at low-x,Q^2
- One possibility is that the data points contain diffractive events but he fits to data from high-x,Q^2 with little-to-no diffractive contribution

What's next?

- Good agreement between the data and Hannu's EPS09 curves for the data without diffraction.

  ➡ Agreement at the 10-20% level

  ➡ Better for e+p than e+Au

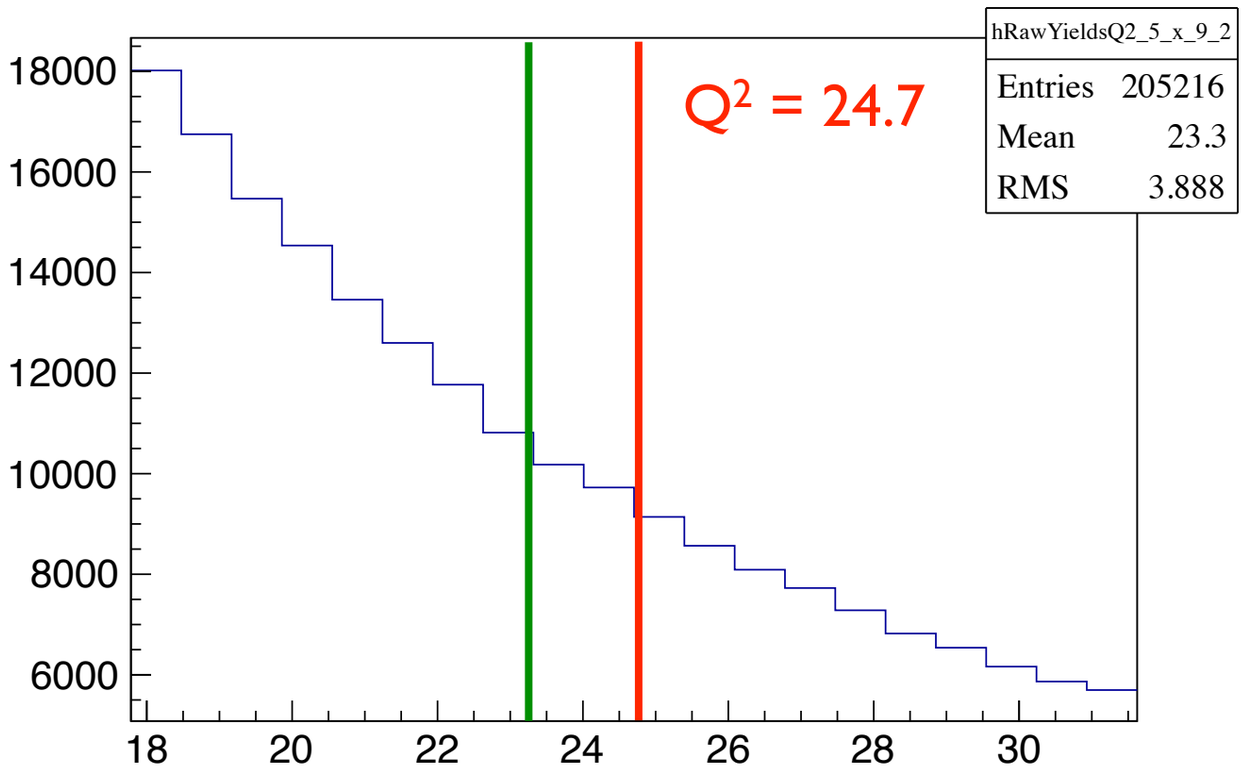
- However, shouldn't these be on top of each other if we used EPS09 as input to our PYTHIA simulations?

- Two possibilities:

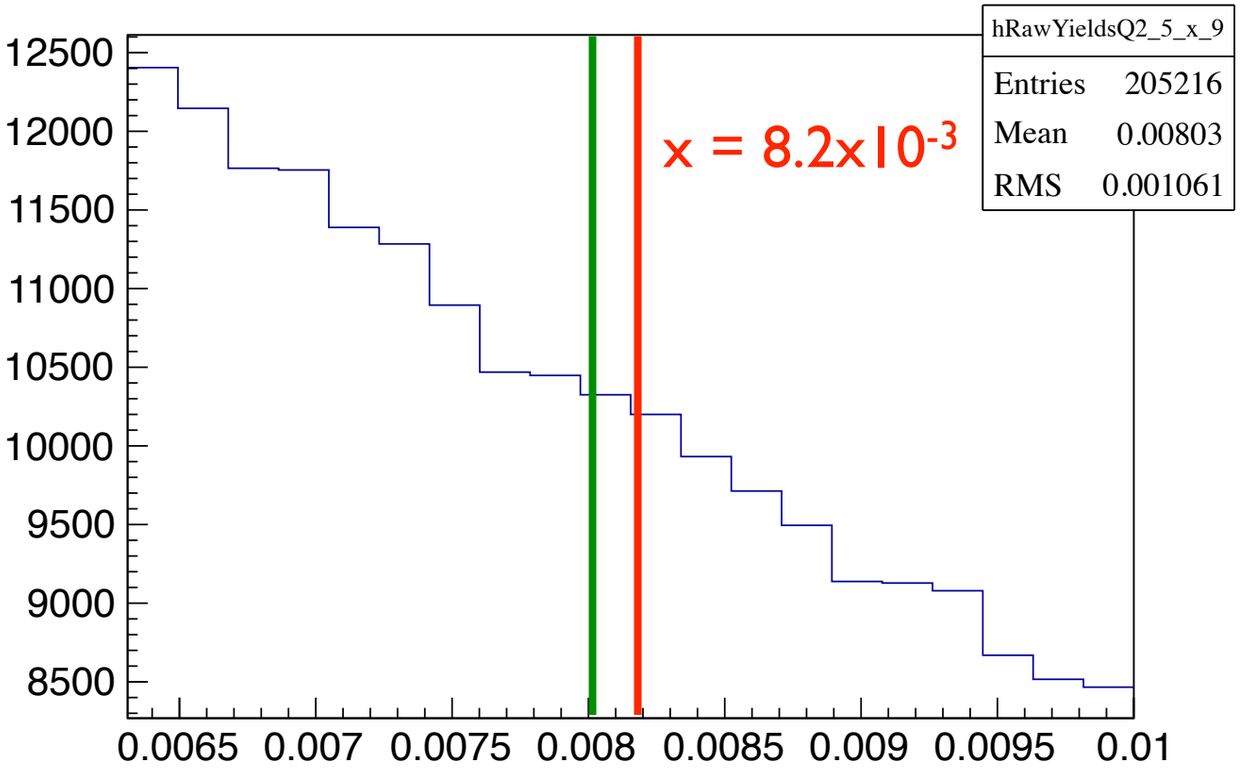
  ➡ EPS09 as used by Hannu has evolved from the one used in LHAPDF (input to PYTHIA)

  ➡ Need to apply a bin-centre correction

Bin-centre Correction - high Q2

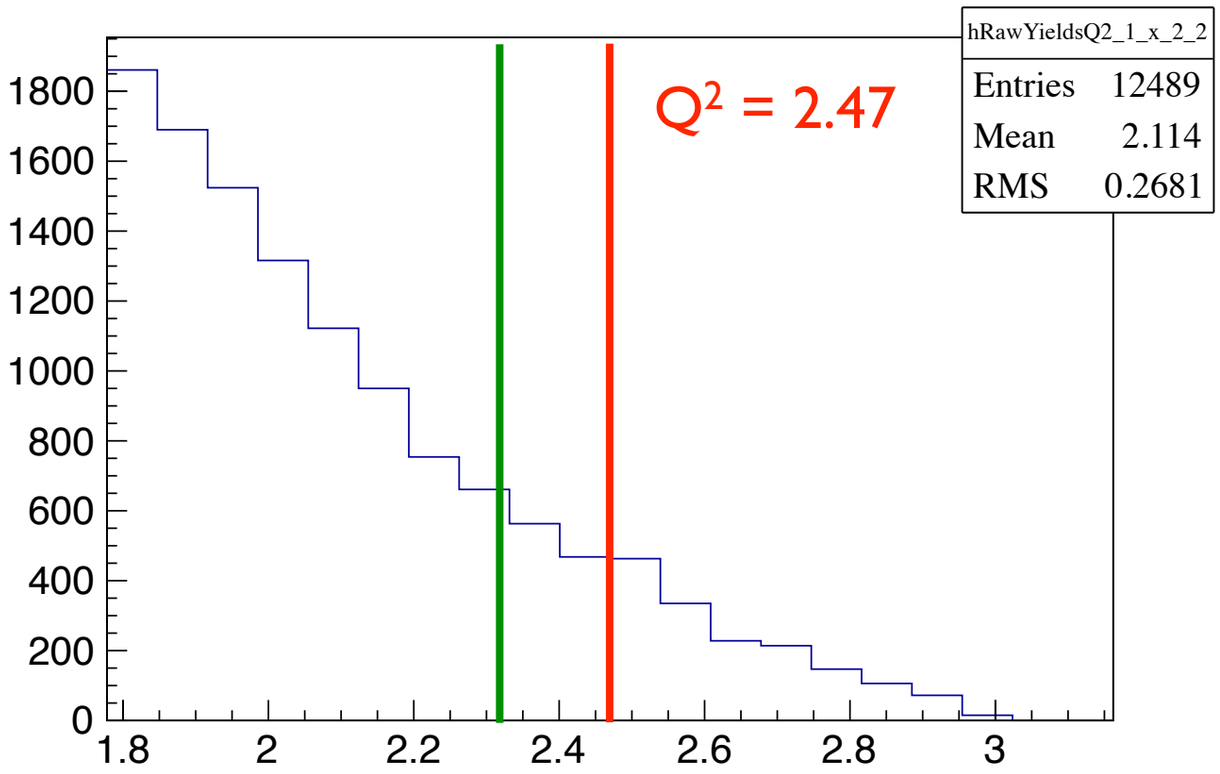


- Plot shows the old positions in red and the actual mean values in green.

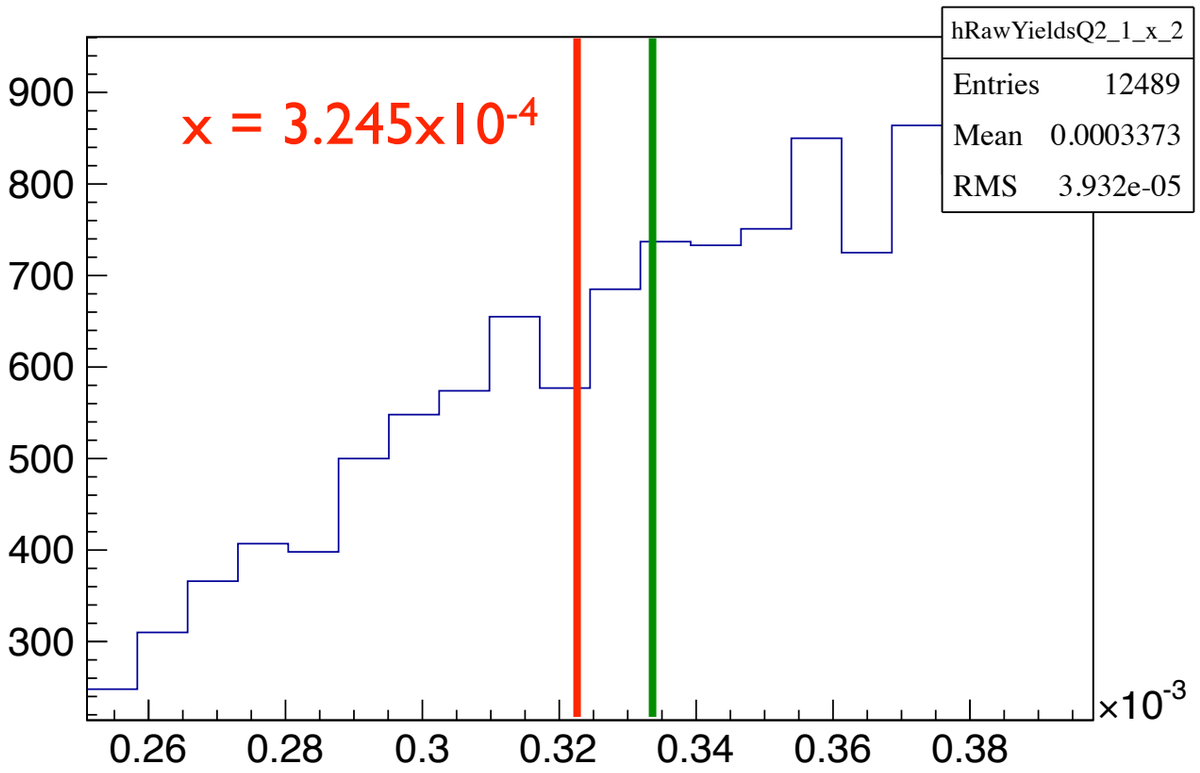


- Note that the actual mean of the bin is slightly lower in both x and Q^2

Bin-centre Correction - low Q2 (i)

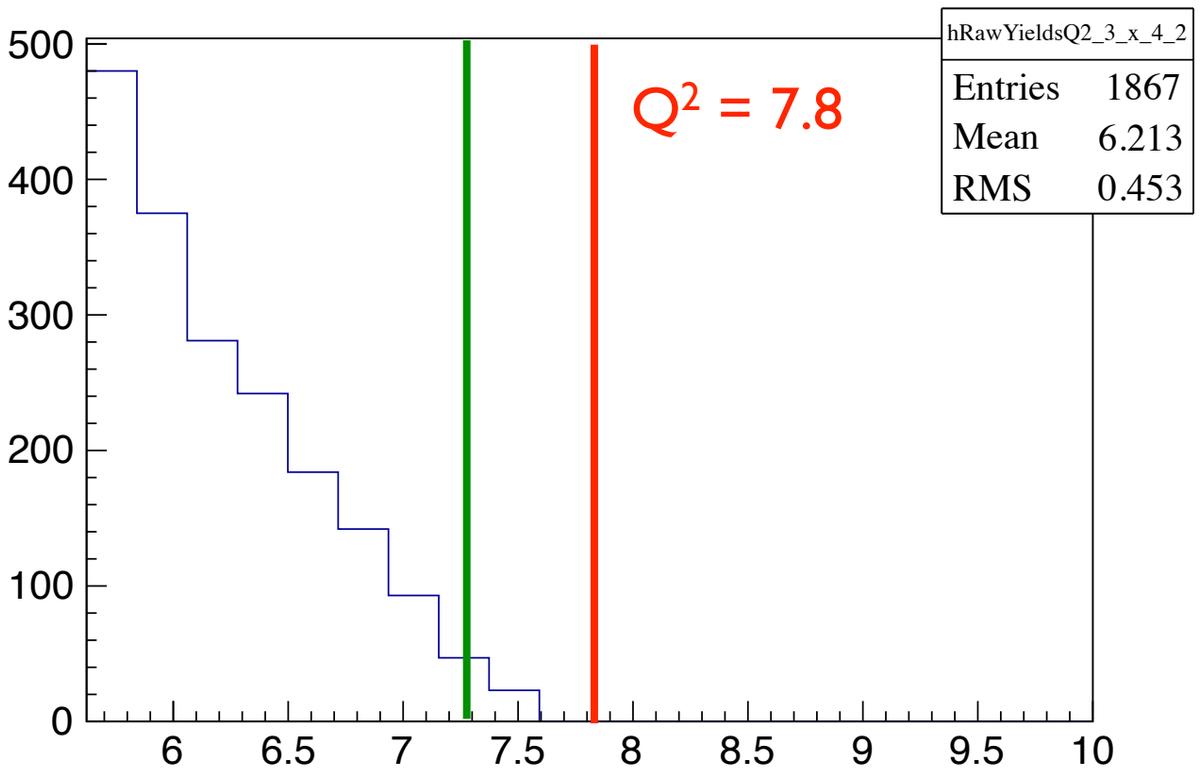


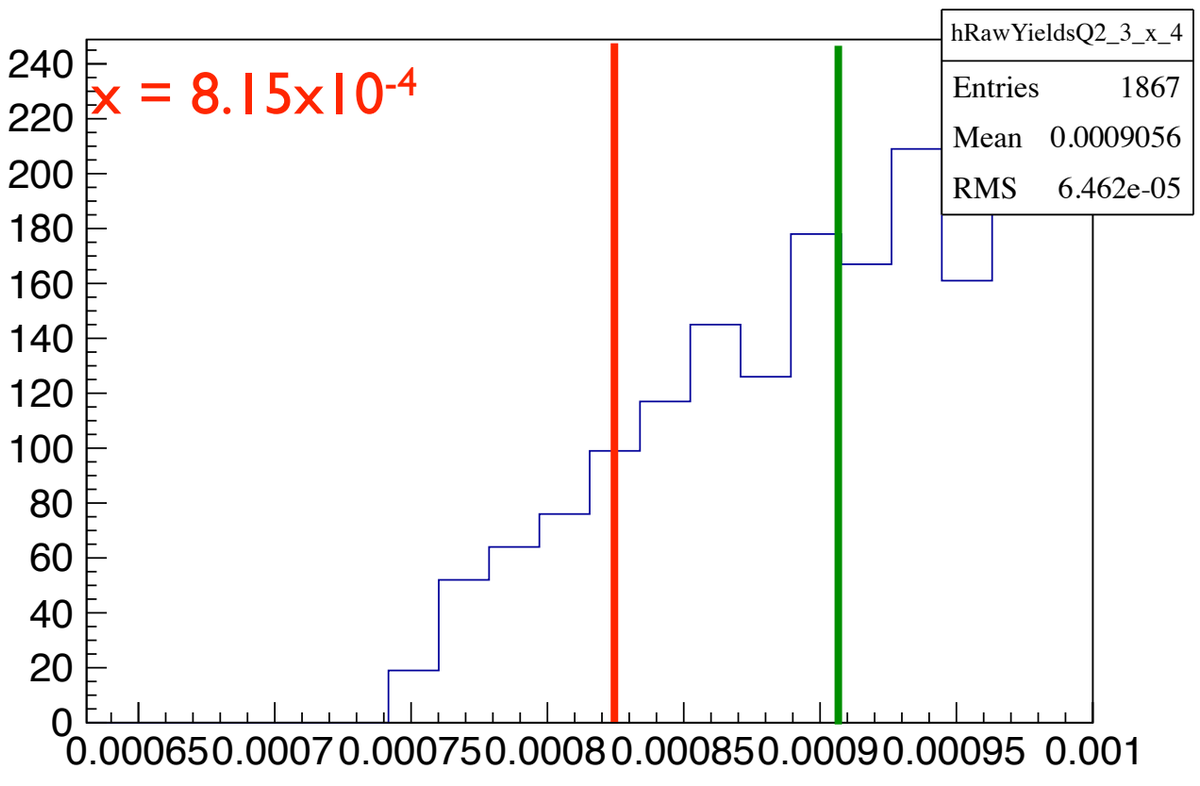
- Plot shows the old positions in red and the actual mean values in green.



- Note that the actual mean of the bin is slightly lower in Q^2 but now higher in x

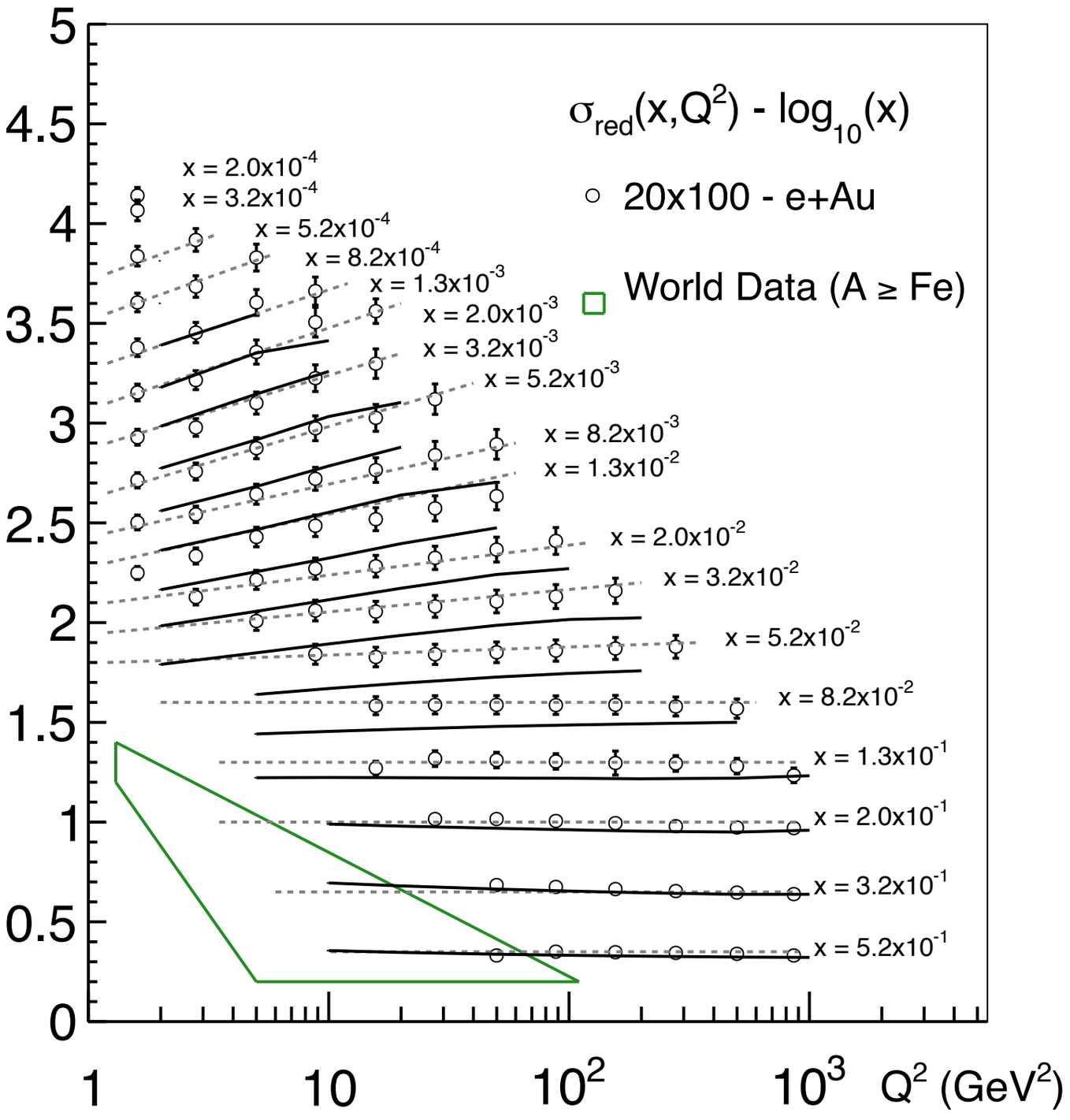
Bin-centre Correction - low Q2 (ii)





- Plot shows the old positions in red and the actual mean values in green.
- Note that the actual mean of the bin is much lower in Q^2 and now much higher in x
- This will bring the point down on the plot significantly

σ_{red} at eRHIC - e+Au@20x100 GeV

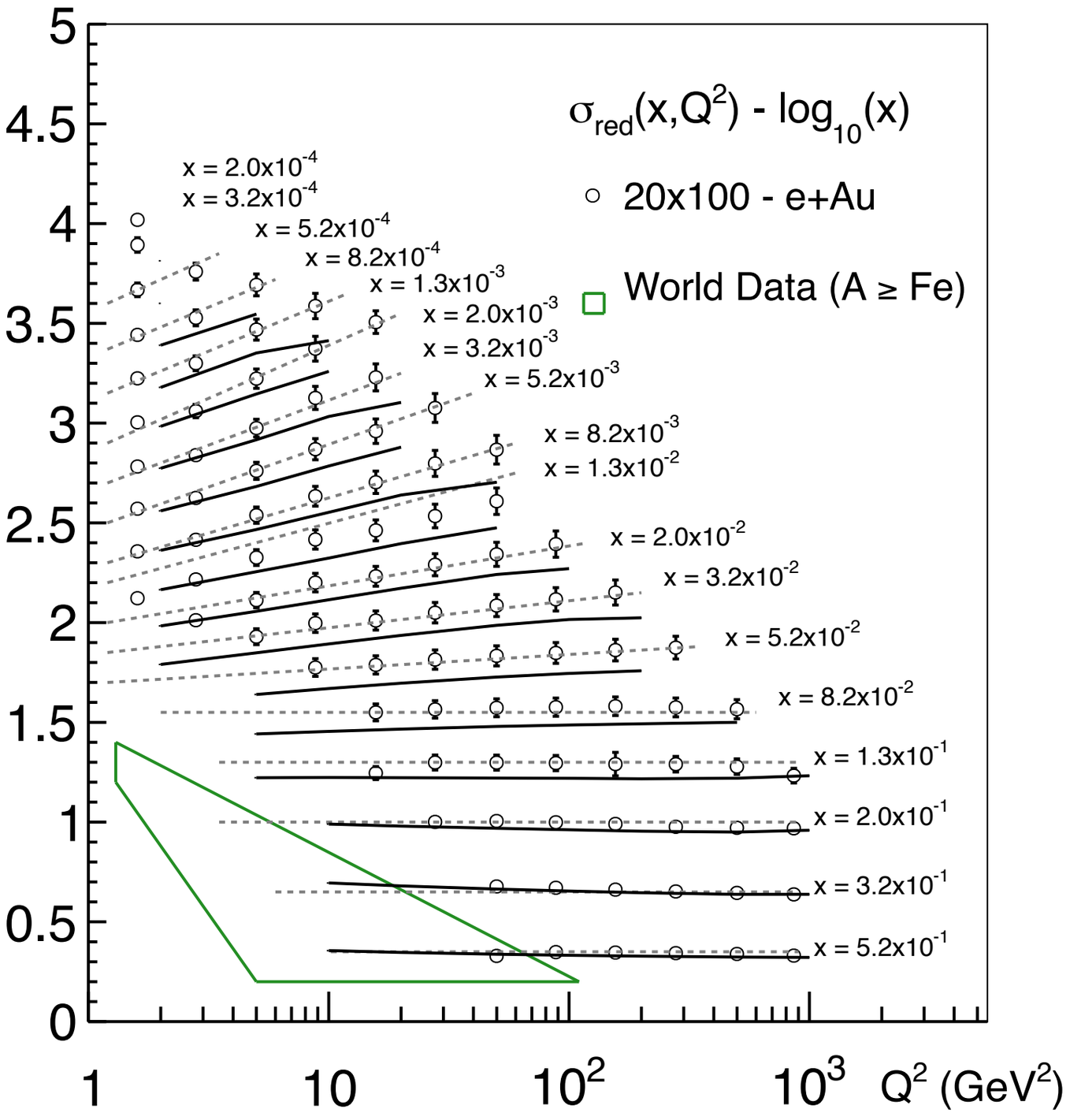


- New scaling - $F_2(x,Q^2)$ - $\log_{10}(x)$
- Dashed lines are there to guide the eye and go through the points
- The solid lines are input from Hannu

  ➡ No uncertainty information from him yet

- Points do a good job at high-x,Q^2 but a poor job at low-x,Q^2
- One possibility is that the data points contain diffractive events but he fits to data from high-x,Q^2 with little-to-no diffractive contribution

σ_{red} at eRHIC - e+Au@20x100 GeV

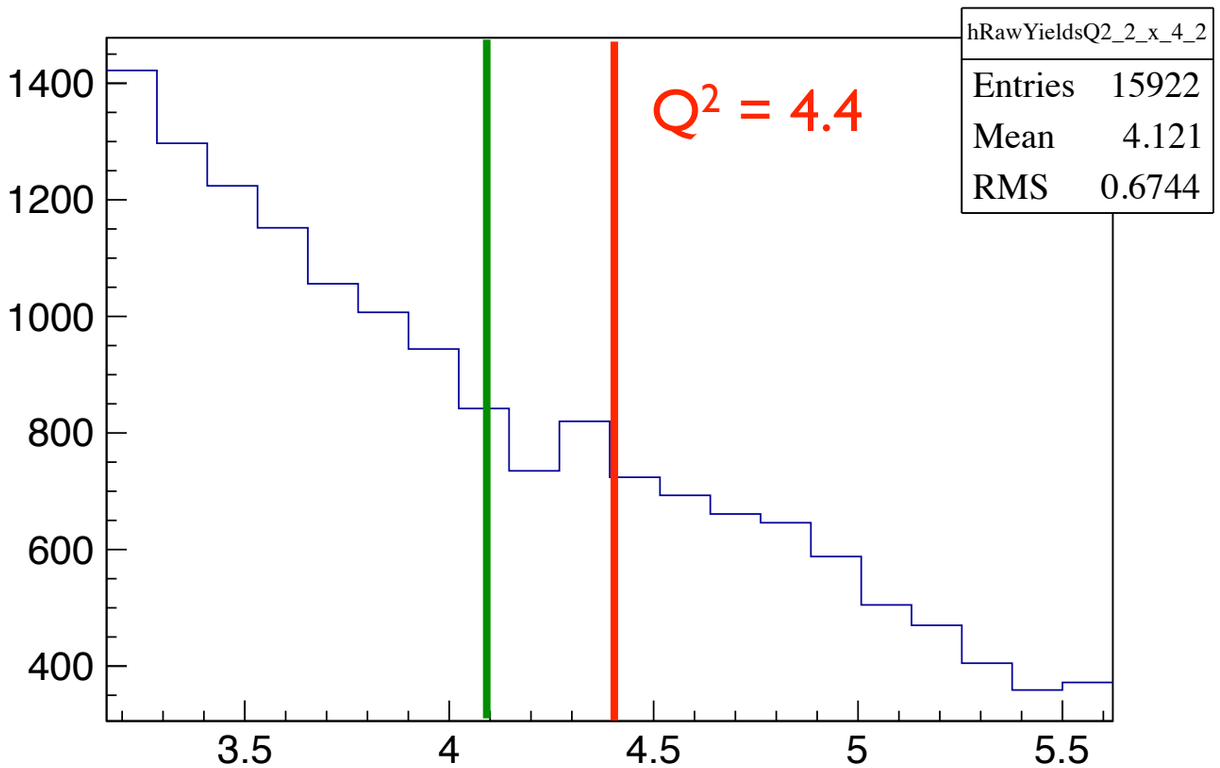


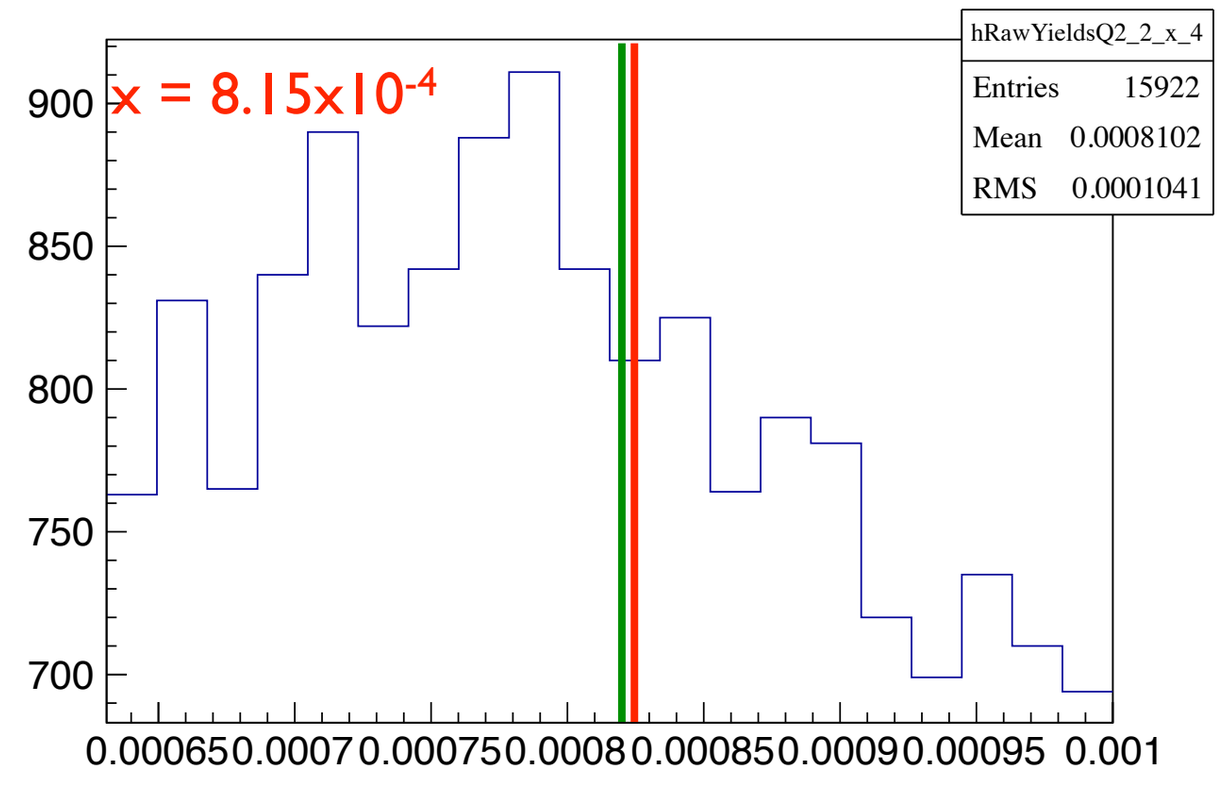
- New scaling - $F_2(x,Q^2)$ - $\log_{10}(x)$
- Dashed lines are there to guide the eye and go through the points
- The solid lines are input from Hannu

➡ No uncertainty information from him yet

- Points do a good job at high-x,Q^2 but a poor job at low-x,Q^2
- One possibility is that the data points contain diffractive events but he fits to data from high-x,Q^2 with little-to-no diffractive contribution

Bin-centre Correction - low Q2 (ii)





- Plot shows the old positions in red and the actual mean values in green.
- Note that the actual mean of the bin is much lower in Q^2 and now much higher in x
- This will bring the point down on the plot significantly

How to proceed?

- We can do the bin-centre correction two ways:
  - ➡ Either we take each bin, fit it and put the point in the correct place
  - ➡ Or, we find out what the correct value of the σ_{red} is for that (x,Q^2) point
- The second way is what we actually want to do otherwise we will end up with lots of points all at different values of x. This way is a lot harder though.
- Alternatively, if we can convince ourselves that this will do the job, at least just be a few percent off from Hannu, we can just move the points onto the curve.
- After all, what we are trying to show from these plots is how well the EIC can constrain EPS09 (for which we need the uncertainties from Hannu…).